

CLAIMS

We claim:

1. A scanning probe system for determining electrical characteristics between two locations on a sample, the scanning probe system comprising:

a stage having a surface for mounting the sample;

a probe assembly including:

a substrate,

a first spring probe having a fixed end attached to the substrate, a curved central section ending away from the substrate, and a free end including a probe tip for contacting a first location of the sample, and

a second spring probe having a fixed end attached to the substrate, a curved central section ending away from the substrate, and a free end including a probe tip for contacting a second location of the sample; and

an electrical measurement device having a first terminal connected to the first spring probe, and a second terminal connected to the second spring probe,

wherein the first and second spring probes comprise stress-engineered spring material films having an internal stress gradient.

2. The scanning probe system according to Claim 1, wherein the substrate is formed from an electrically insulating material, and

wherein each of the first and second spring probes is connected by a respective conductor to the electrical measurement device.

3. The scanning probe system according to Claim 1;

wherein the free ends of the first and second spring probes are shaped to form sharp points, and

wherein the respective probe tips of the first and second spring probes are formed by the sharp points.

4. The scanning probe system according to Claim 1, further comprising:

a third spring probe having a fixed end attached to the substrate, a curved central section ending away from the substrate, and a free end including a probe tip for contacting a third location of the sample, and

a fourth spring probe having a fixed end attached to the substrate, a curved central section ending away from the substrate, and a free end including a probe tip for contacting a fourth location of the sample,

wherein the curved central sections of first, second, third and fourth spring probes are parallel.

5. The scanning probe system according to Claim 1, further comprising a non-conductive tether bar connected between the curved central sections of the first and second spring probes.

6. The scanning probe system according to Claim 1, wherein the non-conductive tether bar comprises at least one of an epoxy and resist.

7. The scanning probe system according to Claim 1, wherein the stage supports the sample in a plane, and wherein the scanning probe system further comprises:

a holder plate for supporting the probe assembly over the stage;

a motor connected to the holder plate for selectively moving the probe assembly relative to the sample in a direction perpendicular to the plane; and

a computer/workstation for controlling the motor to cause contact between the tip of the spring probe and the sample, and for controlling one of the stage and the holder plate to cause relative movement between the stage and the probe assembly in the plane such that the tip scans along the surface of the sample.

8. The scanning probe system according to Claim 1, wherein each of the first and second spring probes further comprise a support portion located between the fixed end and the substrate.

9. The scanning probe system according to Claim 8, wherein the support portion comprises one or more of silicon (Si), silicon-nitride (SiNx), silicon-oxide (SiOx), and titanium (Ti).

10. The scanning probe system according to Claim 1, wherein each of the first and second springs probe comprises one or more selected from molybdenum (Mo), tungsten (W), titanium (Ti), chromium (Cr), nickel (Ni), silicon (Si), silicon oxide (SiOx), silicon nitride (SiNx), carbide, and diamond.

11. The scanning probe system according to Claim 1, wherein each of the first and second springs probes comprises a molybdenum-chromium alloy (MoCr).

12. The scanning probe system according to Claim 1, wherein the substrate of the probe assembly is transparent.

13. The scanning probe system according to Claim 12, wherein the transparent substrate is selected from the group including glass, quartz, and plastic.

14. The scanning probe system according to Claim 12, further comprising:

means for observing a surface of the sample through the transparent substrate; and

means for aligning the spring probe based on information generated by said observing means.

15. The scanning probe system according to Claim 1, wherein the electrical measurement device comprises a voltmeter.

16. A scanning probe system for probing a sample, the scanning probe system comprising:

a stage having a surface for mounting the sample;

a probe assembly including a substrate and a spring probe having a fixed end attached to the substrate, a central section separated from the substrate, and a free end including a probe tip positioned adjacent to the stage surface; and

an electrical measurement device coupled to the spring probe,

wherein the spring probe comprises a stress-engineered spring material film having an internal stress gradient.

17. The scanning probe system according to Claim 16, wherein the stage supports the sample in a plane, and wherein the scanning probe system further comprises:

a holder plate for supporting the probe assembly over the stage;

a motor connected to the holder plate for selectively moving the probe assembly relative to the sample in a direction perpendicular to the plane; and

a computer/workstation for controlling the motor to cause contact between the tip of the spring probe and the sample, and for controlling one of the stage and the holder plate to cause relative movement between the stage and the probe assembly in the plane such that the tip scans along the surface of the sample.

18. The scanning probe system according to Claim 16, further comprising a measurement device for measuring deformation of the spring probe caused by interaction between the probe tip and the sample.

19. The scanning probe system according to Claim 18, wherein the measurement device comprises:

a laser for generating a laser beam that is directed to strike a selected section of the spring probe; and

a photosensor array positioned to receive portions of the laser beam reflected from the selected section of the spring probe.

20. The scanning probe system according to Claim 16, wherein the substrate of the probe assembly is transparent.

21. The scanning probe system according to Claim 20, wherein the transparent substrate is selected from the group including glass, quartz, and plastic.

22. The scanning probe system according to Claim 20, further comprising:

means for observing a surface of the sample through the transparent substrate; and

means for aligning the spring probe based on information generated by said observing means.

23. A scanning probe system for determining electrical characteristics of a sample, the scanning probe system comprising:

a stage having a surface for mounting the sample;

a probe assembly including:

a transparent substrate, and

a spring probe having a fixed end attached to the transparent substrate, a curved central section ending away from the substrate, and a free end including a probe tip for contacting a corresponding location of the sample;

means for observing a surface of the sample through the transparent substrate;

means for aligning the spring probe based on information generated by said observing means such that the tip of the spring probe contacts a first location on the sample; and

means coupled to the spring probe for measuring electrical characteristics of the first location by measuring electrical signals generated on the spring probe.

24. A scanning probe system for determining electrical characteristics of a sample, the scanning probe system comprising:

a stage having a surface for mounting the sample;

a probe assembly including:

a substrate, and

a spring probe having a fixed end attached to the substrate, a curved central section ending away from the substrate, and a free end including a probe tip for contacting a corresponding location of the sample;

means for moving the tip of the spring probe relative to the sample such that the tip of the spring probe scans along a surface of the sample; and

means coupled to the spring probe for measuring electrical characteristics of sample by measuring electrical signals generated on the spring probe.